H. B. Fuqua
With thanks for your help.
M G Cheney

University of Texas Bulletin

No. 2913: April 1, 1929

STRATIGRAPHIC AND STRUCTURAL STUDIES IN NORTH CENTRAL TEXAS

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of democracy. . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar

CONTENTS

ILLUSTRATIONS

In pocket
Plates

This bulletin with the series of maps which accompanies it has been contributed gratuitously for publication by the author, Mr. M. G. Cheney, and the Anzac Oil Corporation of which Mr. Cheney is President. The Bureau is glad to be the medium of publication of the report which will be useful to those interested in natural resource development in north central Texas. The faults and other structural features indicated in the report are in a measure conjectured, and complete accuracy as to their location is not claimed by the Bureau or by the author.

E. H. SELLARDS,
Associate Director
Bureau of Economic Geology.

STRATIGRAPHIC AND STRUCTURAL STUDIES IN NORTH CENTRAL TEXAS

BY

M. G. CHENEY

Petroleum exploration and development in north central Texas have brought forth a great deal of geologic information during the past fifteen years. Many of these data have become available for general use as a result of the coöperative spirit prevailing among the oil companies and individuals who have participated in this work. The present paper is intended to supplement former reports on this area, adding thereto some of the results of later studies and information gained from drilling.

Sincere appreciation is herewith expressed to the many individuals and companies to whom the writer is greatly indebted for geologic data embodied in this paper. The sources of help and friendly coöperation seem too numerous to permit specific mention. P. M. Martin and R. B. Cheney have assisted very materially in gathering and arranging data and in preparation of the maps and cross sections.

MAPS, SECTIONS AND STRUCTURAL FEATURES

AREAL MAP

The accompanying areal map (Pl. I) is a compilation of outcrop data from published reports[1] and from the unpublished results of scores of geologists working in the area.

[1]Drake, N. F., Report on the Colorado Coal Field of Texas, Geol. Surv. Texas, 4th Ann. Rept., pp. 357–481, 1892.

Beede, J. W., and Waite, V. V., The Geology of Runnels County, Univ. Texas Bull. 1816, 1918.

Beede, J. W., and Bentley, W. P., The Geology of Coke County, Univ. Texas Bull. 1850, 1918.

Plummer, F. B., and Moore, R. C., Stratigraphy of the Pennsylvanian formations of north central Texas, Univ. Texas Bull. 2132, 1921.

Merry Bros. and Perini, Outcrop Map Part of Shackelford County, Texas, *Oil and Gas Journal,* June 11, 1925, p. 23.

Beede, J. W., and Christner, D. D., The San Angelo formation and the Geology of Foard County, Univ. Texas Bull. 2607, 1926.

Henderson, G. G., Geology of Tom Green County, Univ. Texas Bull. 2807, 1928.

Submitted May, 1929; published August, 1929.

The task has included supplementing these data in many areas and making certain changes in the published maps required by more recent work. On this map the counties have been marked off into equally spaced coördinates, the minor and major grids being approximately 2 to 10 miles respectively. The purpose of this map is, of course, to show the location of the main escarpment of the more continuous and prominent formations. In some instances the location of outcrop is only approximate or merely indicates where the limestone being traced would occur if present. The joint project of the Bureau of Economic Geology and Committee of American Association of Petroleum Geologists of compiling outcrop data of this area on county maps now in progress will give the location of outcrops more exactly and no doubt make certain corrections. Certain formation names which have come into common use but remained unpublished are listed and defined under the heading "New Formations."

CROSS SECTIONS

Five cross sections prepared from selected well logs are presented. The first beds penetrated have been determined by field inspection for most of the wells, thereby establishing correlations with more certainty for the upper part of the logs. The position of oil and gas bearing beds in these and nearby wells has been indicated as well as the occurrences of water and the color of formations. The vertical scale is greatly exaggerated, being about 88 times the horizontal, to permit showing details of formations penetrated yet include logs for distances of over 200 miles. Logs of wells located at appreciable distances off the lines of section have been raised or lowered in reference to sea level to adjust for regional dip. These sections are as follows: Georgetown to Spur, (Pl. II); Waco to Big Lake, (Pl. III); Fort Worth to Spur, (Pl. IV); McCulloch County to Clay

County, (Pl. V); and Hood County to Fisher County, (Pl. VI).[2]

The areal map and cross sections should be of much value to oil operators in the region. Reference to the former will give the name of the beds outcropping at or near the chosen drilling location, whereupon the approximate depths to usual oil, gas, or water bearing horizons may be calculated by reference to nearest logs of the nearest cross section. Thus the casing requirements, depths at which the diameter of hole should be reduced to test the usual pay horizons and total depth of test may be tentatively determined. More accurate logging of formations should result from comparative stratigraphic studies during drilling.

GENERAL DEPOSITIONAL AND STRUCTURAL INFERENCES

From such criteria as the large amount of sandstone, repetition and extent of coal deposits, and presence of unconformities, it appears certain that the seas in which most of these sediments were deposited were very shallow, probably less than 100 feet deep. This evidence is supported by the conglomerates, mud cracks, ripple marks, cross-bedding, rain pits, and kinds of fossils, which are seen in the exposed beds. It is fundamental, therefore, to think of these beds as having been deposited in a nearly horizontal position and approximately at sea level with the shallow oscillating seas causing or permitting many changes horizontally and vertically in the character of deposit. It is safe to conclude that the thickness of such shallow water deposits affords a record and measure of basin-form subsidence of the earth's crust. The irregularities of strength in the earth's crust and of pressures put upon this crust from various influences must inevitably have caused folding or bending of these deposits as subsidence proceeded. The

[2]The anhydrite and bryozoa horizons in wells in the Georgetown-Spur section were reported by Miss Hedwig T. Kniker, Phillips Petroleum Corporation. The Hood-Fisher County cross section was compiled by W. K. Wender and contributed through the courtesy of the Amerada Petroleum Corporation. References to reports by Hill, Udden, Sellards, Wrather, and Adkins are made on the cross sections. Aid in determining the formations reached in wells used in these sections has been received from various sources, important among which are the records of the Bureau of Economic Geology of the University of Texas.

more prominent structural features so formed must in turn have exerted some localized influence upon the thickness and character of deposit in these shallow seas where waves and currents were no doubt actively at work. Lateral transition in character and variation in thickness of these limestone, shale, and especially the sand deposits as noted in the cross sections will therefore be considered as normal rather than abnormal, whether due to slight oscillations of sea level, to changes in position of the surface of the lithosphere, to the irregular arrival or distribution of material, or to local structural influences. However, in contradiction to this rule, remarkable consistency over large areas is shown by certain limestone members.

CONTOUR MAP OF PRE-MISSISSIPPIAN SURFACE

The sum total of the many structural changes which have affected this region since the beginning of Carboniferous times is indicated by one of the accompanying maps (Pl. VII) which shows approximately the present position of the rock surface upon which the Mississippian deposits accumulated. The formations below this surface are doubtless more folded than those above, as may be observed at their outcrop in the Central Mineral Region and elsewhere. Structurally these pre-Mississippian beds of north central Texas occupy the south flank of a geosyncline, the main axis of which probably extended west-northwest across southern Oklahoma where former land surfaces subsided about 11,000 feet during Cambrian and Ordovician and 500 feet during Silurian and Devonian times. This pre-Mississippian surface appears to have remained at low elevations with irregularities of topography practically eliminated by weathering and eroding processes, for the overlying Barnett and Bend beds which must have been deposited nearly horizontally in shallow water, show comparatively few local changes in thickness over this region. The present thickness of the Mississippian and early Pennsylvanian beds superimposed upon this surface is indicated by dotted lines on this pre-Mississippian map. A thinning of the Bend and Barnett is noted on the higher sides of the faults as well as in the western and particularly the southwestern and northern parts of the region. Apparently both erosion and thinning are responsible for this reduced thickness. This map supplements and extends an earlier contour map on the Ellenburger made by Sellards.[3]

STRAWN THICKNESS MAP

The approximately horizontal position of this old pre-Mississippian surface became greatly altered during Strawn times. The combined thickness of Strawn and earlier Carboniferous beds at any point must represent the approximate position below sea level of this old surface at the close of Strawn times. As shown by Plate VIII, the Strawn group of deposits accumulated in very unequal amounts across this region, being more than a mile thick in the east part but quite certainly never deposited at all in parts of Concho and McCulloch counties where the Canyon beds rest directly upon the Bend. It appears probable that the Strawn was deposited very thinly if at all over the prominent structural features of the Red River district. In the eastern part of the area the rate of westward thinning of the Strawn is at least 100 feet to the mile, indicating an average slope of slightly more than 1 degree in underlying rocks. In the central and western parts the thinning averages 25 feet per mile or less. The thinning is due mainly to non-deposition of lower members, hence the Strawn may be thought of as the deposits of a progressive marine overlap. The gradual oscillatory westward advance of the east shore as well as of the west shore of this epicontinental sea is indicated by the more and more westward occurrence of conglomerates in upper Strawn and later beds. These conglomerates grade into normal sandstones westward. A minor amount of the westward decrease in thickness is due to thinning of beds rather than to this absence of basal members.

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[3]Sellards, E. H., Underground Position of the Ellenburger Formation. Univ. Texas Bull. 1849, 1918.

Plate VIII is intended to show the original thickness of the Strawn and this necessarily involves estimates of the amount of beds eroded in areas east of the Palo Pinto limestone escarpment. Several factors render these estimates uncertain, and the figures given may quite as likely be underestimates as overestimates.

This map discloses certain important regional features which were largely developed during Strawn times, namely, the Bend flexure, Concho divide, Muenster arch, and Electra arch which will be described in order.

BEND FLEXURE

The Strawn beds at their outcrop along the Brazos and Colorado River valleys dip toward the west and northwest at the rate of from 50 to 200 feet per mile. Restoration of these beds to their former nearly horizontal position furnishes good evidence that the pre-Strawn beds suffered extensive subsidence to the east-southeast during early and middle Strawn times and to the northeast during late Strawn time. Plate VIII, shows two trends of marked changes in the rate of westward thinning of the Strawn, the first from Comanche County northward through eastern Eastland, Stephens, and Young counties, the second from western San Saba northward through western Brown County. A general eastward monoclinal slope must have developed in pre-Strawn beds during accumulation of the Strawn but with much more gentle dips in areas west of these trends than east of them. The obvious result was a flexing of the Bend and older beds along these trends. As a result of westward tilting during upper Pennsylvanian and Permian times (incidental to extensive uplift of eastern areas indicated by extensive erosion of the Paleozoic deposits of Balcones fault region and subsidence of very broad areas to the west permitting accumulation of about 10,000 feet of late Pennsylvanian and Permian in western Texas), these flexed pre-Strawn beds have taken on a geanticlinal appearance. But as no anticlinal uplift occurred along these trends any term suggesting arching or anticlinal uplift is inapt and use of the term "Bend flexure" or for more exactness the "Comanche-Young Bend flexure" and the "San Saba-Callahan Bend flexure" is urged as being more nearly correct and less likely to permit continuance of the present practice of some geologists of making structural deductions based on an arched uplift which never occurred. The present high Bend area of north central Texas is due therefore not to unlift but to less subsidence (1) during Strawn times than areas to the east and (2) during the late Pennsylvanian and Permian than areas to the west. Much of this eastward subsidence was accomplished by normal faulting which in some cases evidently began quite early for certain wells near each other but on opposite sides of the more prominent faults show a greater thickness of Marble Falls lime on the lower than on the higher side. However, most of these tensional displacements must have occurred during lower and middle Strawn for the upper Strawn exposed in the Colorado River region shows but little if any faulting along these very pronounced fault trends. Further drilling will no doubt prove up other faults and locate those already disclosed more exactly. One is reminded of the succession of normal faults of northeast Oklahoma on the north side of the McAlester basin, affecting beds as young as middle Cherokee and extending laterally more than 80 miles in the case of the Seneca fault.

CONCHO DIVIDE

The pronounced thinning or absence of Barnett, Bend, and Strawn deposits noted in Concho and McCulloch counties indicates a broad persistently positive trend which resisted subsidence, while the southwest Ouachita and Strawn basin areas to the northeast and the Tesnus basin area to the southwest were undergoing extensive subsidence in Mississippian and early Pennsylvanian times. It is assumed that thick Mississippian deposits did accumulate in east central Texas forming a southwest extension of the Ouachita basin of central Arkansas and southeast Oklahoma and lying somewhat east of the Strawn basin. The location and development of these successive basins have been illustrated and discussed in detail among others by McCoy[4] and more recently by the writer.[5] The main axial trend of this intervening area of least subsidence was northwest-southeast and since its flanks were very gentle it has been referred to as a "divide" rather than an arch.[6] This feature very likely was peninsular in form during much of its development, probably permitting the Mississippian and early Pennsylvanian seas of the Ouachita-Strawn and Tesnus basins to join more or less continuously around its southeast limits. The Concho divide was fundamental to the Llano-Burnet uplift. It had little effect upon sediments accumulating later than earliest Canyon.

MUENSTER ARCH AND ELECTRA ARCH

An early well drilled near Muenster in western Cooke County discovered pre-Mississippian beds at a surprisingly shallow depth.[7] Subsequent drilling has disclosed a very prominent structural arch running northwest-southeast from northern Montague to northeast Denton County as shown on the pre-Mississippian surface map Plate No. VII. It is thought that this arch at an early date persisted northwest across the southern Wichita Mountain area of Oklahoma. Partly for this reason and partly because Canyon beds (possibly some Strawn) are present, this arch is thought to be distinct and to have had a somewhat different history than the equally prominent arch which extends from northern Clay as far west at least as eastern Foard County and which is herein referred to as the Electra arch, these names having been suggested in an earlier paper.[8]

The very great structural prominence of these arches is graphically shown in the McCulloch to Clay County log

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[4]McCoy, A. W., Paleogeography and Historical Geology of the Mid-Continent Oil District, Bull. Am. Assoc. Petr. Geol., Vol. 5, 1921, pp. 541–84.

[5]Cheney, M. G., History of the Carboniferous Sediments of the Mid-Continent Oil Field, Bull. Am. Assoc. Petr. Geol., Vol. 13, No. 6, 1929, pp. 557-594.

[6]Cheney, M. G., Pre-Mississippian Production in Texas, *Oil and Gas Journal*, April 12, 1928, pp. 31–33.

[7]Udden, J. A., Aids to the Identification of Geologic Formations, Univ Texas Handbook, Series No. 1, p. 55.

[8]Cheney, M. G., *ibid.* (5).

section, Plate V, which shows that the beds between Ellenburger and Cisco are entirely lacking on what has been termed the Petrolia uplift, this being the eastern part of the Electra arch. This hiatus seems to be equally great or even greater on the higher parts of this arch to the west.

There is considerable evidence that these arches took form primarily due to stability of their areas rather than to uplift and that their structural relief is mainly due to nonsubsidence. They perhaps were alternately subsided and uplifted a few hundred feet during Mississippian and Pennsylvanian pre-Cisco times in contrast to some twenty-five thousand feet of subsidence in the Ardmore basin to the northeast and three to six thousand feet of subsidence in the present synclinal areas to the southwest and south. It is probable that the missing beds were in part eroded but for the most part their absence is due to rapid thinning on the flanks of these arches. It seems certain that much faulting has occurred along the flanks of these prominent features incidental to extensive subsidence of the flanking areas.

POST-CARBONIFEROUS TILTING

Added to the eastward tilting during the Strawn and westward tilting during later Carboniferous, the north central Texas region has been affected by a third major movement starting in Lower Comanche, or earlier times. This permitted Trinity deposits to a thickness of 1,250 feet to accumulate in areas which had undergone extensive erosion in late Carboniferous as at Waco (Plate III) as against about 100 feet of deposit in former basin areas to the west. This reversal of relatively high and low positions may be roughly measured by the present position of the old erosion surface which Hill[9] called the Wichita Paleoplain in Texas and Oklahoma.

The rate and direction of slope of this old surface changes considerably, being about 6 feet per mile from west Texas to the area north of the Central Mineral Region, about

[9]Hill, Robert T., Geography and Geology of the Black and Grand Prairies, Texas. U. S. Geol. Surv., 21st Ann. Rept., pt. 7, p. 363 (1901).

20 feet per mile east of this to the Balcones fault zone, and 100 feet per mile east of this fault zone. Much variation of subsidence is noted in a northeast-southwest direction, for near Eagle Pass the base of the Trinity is more than a mile below sea level (Rio Grande embayment), in the Central Mineral Region more than 1,500 feet above sea level, at Mexia more than one mile below sea level (East Texas embayment), and in the Boston Mountains of western Arkansas nearly one-half mile above sea level. It would seem that only a minor part of these differences may be explained by topography or differential erosion.

SOUTHWEST EXTENSION OF THE OUACHITA MOUNTAINS

Restoration of this old paleoplain surface to its former nearly horizontal position in east central Texas emphasizes the high structural position of the deeply eroded metamorphosed zone which extends as far west as Georgetown and Hillsboro, and trends northeast toward the Ouachita Mountains of southeast Oklahoma. That east central Texas experienced much the same geologic history as did southeast Oklahoma, has long been advocated and is becoming more and more evident. The writer believes that the main events of this Ouachita development were an extensive geosynclinal subsidence during Mississippian and Early Pennsylvanian, orogenic deformation during Strawn times, and regional elevation during the remainder of Carboniferous times. The Marathon district of southwest Texas appears to be yet another salient of Appalachian basining and orogeny.

OIL BEARING STRUCTURES

In north central Texas the oil bearing structures occur mostly (1) along the higher side of the faults of the northeast trending fault system indicated in Plate VII (many minor faults omitted) and (2) en échelon along certain nearly east-west trends flanked by several folds of diminishing importance. Drilling discloses that as the main structural axes are approached the sediments become thinner causing the main folds to increase and the flank folds to decrease in relative importance with depth. This thinning is usually due not to erosion but to a decrease in thickness of several formations. Since the entire region was undergoing subsidence it would seem logical to conclude that tension rather than compression was prevailing and that these main folds were areas which repeatedly experienced less subsidence than surrounding areas. Extensive subsidence of any broad area of the earth's crust seems to call for withdrawal of subcrustal plastic material from beneath the subsiding area, this withdrawal being somewhat irregular due to variations in the crustal and subcrustal rock masses. Migration of this material would be directed toward the area where erosion had lightened the crust and thus induced erosional uplift. No doubt uneven upward movement takes place in the crust of any area which is undergoing gradual elevation. This process no doubt affected large portions of north central Texas during early and Middle Strawn and late Permian times.

The movement of fluids in these lenticular beds seems to be mainly limited to the period of increasing overburden and consequent compaction of muds. According to experiment[10] most of the oil would be squeezed out of the muds by the first few hundred feet of overburden. Insofar as porosity permitted, the oil would tend to migrate to and remain bouyed up by water in areas where least pressures prevailed during this early period of active migration. Thus theoretically oil accumulations should be expected in areas where early folding caused abnormally thin deposition.

In this region a fold seems to be of doubtful promise structurally as an oil prospect unless it is more prominent than neighboring folds and rises conspicuously (at least 25 feet for an area of 100 acres or more) above the normal dip plane into which these sediments have been tilted. Many oil pools are explainable not by structure but by reservoir conditions. These conditions are not subject to pre-

[10]Beckstrom, R. C., and Van Tuyl, F. M., Compaction as a Cause of the Migration of Petroleum. Bull. Am. Assoc. Petr. Geol., 12 (1928), pp. 1049–1055.

diction in advance of drilling. Apparently base levelling was too complete and compensation too prompt to permit buried hills or differential compaction of varying sediments to operate as important causes of folding.

LLANO-BURNET UPLIFT

These local folds in north central Texas have frequently been explained as due to pressures coming from the Llano-Burnet uplift (Central Mineral Region). However, there seems to be no appreciable increase in the slope of the Ellenburger surface as this region is approached from any given direction and its elevated position appears to be a result not of uplift with lateral crowding but mainly of stability during early Carboniferous times while areas to the northeast and southwest underwent extensive subsidence, during later Carboniferous while areas to the west became depressed about two miles, and in post-Paleozoic times while the Rio Grande and East Texas embayments and general coastal subsidences were occurring. Continental elevation and tilting have permitted erosion to strip off the sedimentary deposits and to expose the older, much folded beds. It seems most unlikely that this broad domal region which has itself suffered a minimum of movement since Mid-Paleozoic times could have caused folding of a burdened crust in areas scores of miles distant.

STRATIGRAPHIC RELATIONS

The cross sections display the general characteristics of the sediments in north central Texas; however, brief generalizations may be helpful to those not already familiar with the stratigraphy of this region. For faunal collections, detailed description of outcrop, sections, and review of the geologic literature of this region, the reader is referred to the general report by Plummer and Moore.[11]

For the convenience of oil operators, these sediments will be discussed in the order in which they are penetrated by the drill.

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[11]Plummer, Federick B., and Moore, Raymond C., Stratigraphy of the Pennsylvanian Formations of North-Central Texas, Univ. Texas Bull. 2132, 1921.

PERMIAN

DOUBLE MOUNTAIN GROUP

At their outcrop, the Double Mountain beds consist of more than 2,000 feet of shale, sand, thin dolomite, anhydrite, gypsum, and salt deposits. They overlie a basal series of shales and sands known as the San Angelo formation. Salt has been mined from these salt beds at Colorado City in Mitchell County. Of more economic importance than the salt, however, are the lower beds which to the west become almost entirely anhydrite and dolomite with certain porous and oolitic members which have produced oil prolifically at Big Lake and in other pools of West Texas. Oolitic members have been noted along the outcrop in Stonewall County and elsewhere in these early Double Mountain beds of north central Texas. Much gypsum is present and is used commercially by several gypsum plants in Nolan and Hardeman counties. The basal San Angelo beds are equivalent to the Duncan sandstone of Oklahoma and extend far basinward as noted in the cross sections. Bituminous sands of lower Double Mountain age outcrop in Coke County and produce oil in the Chalk field of southern Howard County.

CLEAR FORK GROUP

Following certain earlier reports, the Clear Fork beds are herein treated as extending from the base of the San Angelo formation to the top of the Standpipe limestone, which outcrops in the city of Abilene. These beds are mostly sandy shales with occasional sands and dolomite beds at the outcrop where it may be noted that the dolomites disappear northward and increase southward from Haskell County. These beds also become more dolomitic on the west of the area of outcrop, and become continuous dolomite in some parts of the basin. Some of the oil of West Texas is apparently derived from these beds, particularly the Morrison pay at 3,000 feet in the Westbrook field in Mitchell County.

WICHITA-ALBANY GROUP

This group at its outcrop from Shackelford County south is a series of thick limestones and shales with very little sandstone. The limestones decrease in importance northward so that they are practically absent near the Red River. Some shallow oil has been produced in Wichita County and some coal has been mined from these beds near Coleman, but they have little economic importance at present except for clay for brick manufacture and limestone for building purposes.

PENNSYLVANIAN

CISCO GROUP

This highest group of Pennsylvanian beds has to date produced more oil than any other group in north central Texas, the main production having come from the fields of Wichita, Archer, Wilbarger, Young, Shackelford, Callahan, Jones, and Coleman counties. Besides the many oil bearing sands and a few productive limestone members, this group carries commercial coal deposits which have been mined in Montague, Jack, Young, Coleman, and McCulloch counties.

The effect of the Arbuckle-Wichita uplifts which were developing actively in early Cisco and preceding times is very evident in the Cisco as well as beds above and just below this group. The Cisco of McCulloch County includes nearly as much limestone as shale and only occasional sandstones. The limestones become much thinner northward and most of them are difficult to follow northeast from Young and Jack counties. On the other hand, sands increase in prominence, become coarsely conglomeratic, and the group thickens by approximately 50 per cent as it is traced northward across this region. Arkosic materials derived after extensive erosion had removed sediments from the granite of the Arbuckle and Wichita uplifts, make their appearance in north central Texas about the middle of Cisco times above the Saddle Creek limestone.

CANYON GROUP

Thick limestone deposits with intervening shales and occasional sands characterize the Canyon Group over much of this region. However, the lower Cisco of the southern part and the upper Strawn of the central part carry limes unusually thick for the Pennsylvanian of this region. The effects of the Arbuckle uplift, are clearly observed in this group, for conglomerates locally replace some of its limestone members in Young and Jack counties and a very notable increase of shale and sandstone thicknesses develops in Jack and Wise counties. Difficulty has been experienced in the past in carrying the upper member of the highest formation of this group, the Home Creek limestone, northeast from southeast Young County. Recent work by the geologists of the Prairie Oil and Gas Company indicate that what has formerly been called "Jacksboro lime" should be considered as the top member of the Canyon Group instead of being lower Cisco. The "Jacksboro lime" of southwest Jack County and southeast Young County is at the position of the Gonzales lentil of lower Cisco, being about 100 feet above this highest member of the Canyon; the previous confusion of beds evidently occurred in the district northeast of the Preston oil pool of southwest Jack County.

A second revision of correlations of Canyon beds is necessary in tracing the Clear Creek and Adams Branch limestones northward from their type locality of central Brown County. North of the Cretaceous overlap of central Eastland County the Clear Creek has become known as the Merriman and Adams Branch limestones, and the Adams Branch as the Staff limestone. This error seems to have arisen through the occurrence of two thin *Fusulina* beds about 200 feet apart in the northern part of the region as compared to but one in the Brownwood section. The writer believes that the correlative of the *Fusulina* bed about 70 feet below the Adams Branch lime near Adams Branch crossing about 2 miles west of Brownwood is seen about 1.4 miles northeast of Metcalf Gap Junction on State Highway

No. 1 in western Palo Pinto County, some 300 feet stratigraphically below the so-called Adams Branch of that district. The two *Fusulina* beds of the northern district were noted by Dobbin[12] in southeast Stephens County.

In recent years the Canyon has furnished several profitable oil fields at four different horizons, the highest being near the Ranger lime member in southeast Throckmorton County; the second between the Clear Creek and Adams Branch limes as in the Cross Plains pool of southeast Callahan County; the third, between the Wiles and Palo Pinto limes in the Cross Cut and Blake pools of northern Brown County, and the fourth near the position of the base of the Palo Pinto lime in several pools (including the Morris, Dibrell, Breneke Moody) in Coleman and Brown counties.

STRAWN GROUP

The great wedge-shaped group of sediments known as the Strawn has been divided into an upper rather uniform Mineral Wells group and lower thicker and very irregular Millsap group. These beds which are mostly clastics have already been discussed under the heading "Strawn Thickness Map" and "Bend flexure." Besides important coal deposits near Strawn many oil pools over north central Texas have been developed from this group at varying stratigraphic positions (at least 8 in number) as may be noted in the cross sections. Drill cuttings show the lower Strawn to be arkosic as are the early Pennsylvanian beds of southeast Oklahoma. Much coarse material in the form of chert conglomerate appears in increasing quantities in the middle and upper Strawn which, it is believed, was derived from the chert bearing Ouachita basin and its southward extension into east central Texas indicating, of course, that this great Ouachita geosyncline was experiencing mountain building movements during Strawn times of which there is further definite proof to be found in the sediments and structures of Oklahoma.

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[12]Dobbin, Carrol E., Geology of Wiles Area Ranger District, Texas. U. S. Geol. Surv., Bull. 736, 1922, p. 61.

BEND GROUP

The upper beds of this oldest group of Pennsylvanian beds in north central Texas have been named the Smithwick shale. At their outcrop around the north and east sides of the Central Mineral Region they are divisible into an upper grayish shale which carries some fossils and a lower non-fossiliferous black shale. It appears from well logs that the upper beds grade westward into limestone along a transitional zone extending from eastern McCulloch County northward to western Jack County. Somewhat further west the highest Smithwick beds also become limestone. The basal 100 feet, more or less, of Smithwick shale persists as shale over most of the area, frequently being reported as cavey in its lower portion.

The Marble Falls which underlies the Smithwick consists of fairly uniform limestone beds at its outcrop but undergoes considerable change as it is traced northward by well records. In certain areas as near Bangs, west central Brown County, the thickness of the Marble Falls is less than 300 feet and the total thickness of its limestone members less than 100 feet. The tendency of the Marble Falls seems to be to thicken northeastward and eastward and to vary a great deal in the position and percentage of its limestone contents. Reeves'[13] report on the Ranger oil field gives the results of an extensive study on these and younger beds.

The Bend group has furnished much of the oil produced in north central Texas, the oil coming from at least four different stratigraphic positions in the Smithwick and from as many or more porous horizons of the Marble Falls which in many cases seem to be due to solution of limestone and deposition of silica in the cavities as evidenced by rather large perfect quartz crystals found at different positions in the upper 200 feet of the Marble Falls beds. However, some of the sand reported from the Bend seems to be true

[13]Reeves, Frank, Geology of the Ranger Oil Field, Texas. U. S. Geol. Surv., Bull. 736, 1922, p. 111.

sand deposited *in situ* with some conglomeratic material mixed with it as in a well near Ranger.[14]

The oil occurrence in the upper Smithwick seems to be related to highest limestone reservoir in some areas rather than to high structural position of some particular member of these transitional shale-limestone deposits; thus the accumulation of oil in the Breckenridge pool may be due partly to the unusually thick Smithwick lime section there. It appears that these Bend beds of the flexed area and west thereof have suffered erosion and solution to some extent while the lower Strawn was being deposited in the east. Extensive fracturing associated with the fault system shown on the pre-Mississippian surface map (Plate VII) may explain the occurrence of large initial yields from the dense non-porous Bend limestones in certain areas, as from the "Caddo black lime" of east central Stephens County. Many wells have reported crevices in the Bend and Ellenburger limestones.

MISSISSIPPIAN

BARNETT GROUP

A distinct faunal change occurs about 50 feet above the base of the limestone beds which would lithologically be called Marble Falls limestone. There is much uncertainty as to where this pronounced hiatus occurs over the region north of the outcrop on the north and east sides of the Central Mineral Region. Goldman[15] believed this change occurred at 4,300 feet in the Seaman No. 1, drilled by Roxana Petroleum Corporation in northwest Palo Pinto County (See Plate V). This limestone and the underlying brown and black shales are known as the Barnett group and commonly assigned to the Mississippian, whereas most paleontologists classify the overlying Marble Falls limestone as Pennsylvanian in age. An underlying fossiliferous limestone varying from a few inches to a few feet thick, and

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[14]Donoghue, David, Note on Ranger Sand, Eastland County, Texas. Bull. Am. Assoc. Petr. Geol., Vol. 11, p. 635, 1927.

[15]Goldman, Marcus, Lithologic Subsurface Correlation in the "Bend Series" of North-Central Texas. U. S. Geol. Surv., Prof. Paper 129-A, 1921.

absent in some core-drilled tests of north central Texas, has been classified as Mississippian of Boone age.[16]

Some bedded chert deposits below this thin lime and resembling the Woodford chert of Oklahoma were seen by P. M. Martin and the writer about 5 miles southwest of Lampasas.

PRE-MISSISSIPPIAN

The beds underlying the Mississippian deposits are probably the least understood and at the present time the most inviting for further study of any beds in north central Texas because of their possible relationship with the very prolific oil bearing beds of the Seminole district in Oklahoma. Undoubtedly much-folded and well base-levelled beds were exposed in north central Texas as in Oklahoma and Kansas prior to inundation by the Mississippian seas.

Pre-Mississippian beds have yielded small quantities of oil and gas in many wells over north central Texas as noted on the pre-Mississippian map (Plate VII) and previously reported by the writer.[17] However, the number of profitable wells so far completed is limited at present to three or four wells in the South Bend pool southern Young County and the Johnson No. 1, drilled by Empire Gas and Fuel Company, in south central Callahan County. In the former pool, the McCluskey No. 7, of the Panhandle Producing and Refining Company, had an initial daily yield of 6,000 barrels and total recovery in excess of 1,000,000 barrels. Correlations (based on fossils) made by Ulrich and geologists of the Amerada Petroleum Corporation, have determined this lime pay as of Richmond age, (the lower Silurian of Ulrich). It is a coarsely crystalline gray lime and therefore of the same appearance, as well as age, as the upper Viola of the Seminole district.[18]

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[16]Roundy, P. V., Girty, George H., and Goldman, Marcus L., Mississippian Formation of San Saba County, Texas. U. S. Geol. Surv., Prof. Paper 146, 1926.

[17]*Ibid.* (6).

[18]Edson, Fannie C., Pre-Mississippian Sediments in Kansas. Bull. Am. Assoc. Petr. Geol., Vol. 13 (1929). Correlation Chart, p. 457.

Production seemed to increase in the South Bend pool during penetration of the upper 50 feet of this lime. In a nearby well, the Roxana Petroleum Corporation, Scott No. 9, a strophomenoid, probably Silurian in age according to Ulrich, was secured from a sample following a shot at a depth of 4,360 to 4,400 feet. The base of the Barnett was at 4,255. Deeper drilling in another nearby well found a nearly continuous section of light colored limestone for about 600 feet below the Barnett. The main pay in the Johnson well was about 80 feet below the Barnett, but it is believed that the upper Viola was absent in this well.

It is interesting to note that the middle Viola is described as a finely crystalline, cream-colored limestone (Cincinnatian, upper Ordovician) and the basal Viola (basal Trenton) as a dense lithographic limestone in the Arbuckle region and Seminole field. This is the usual characteristic of the upper 100 feet more or less of Ellenburger as found in most wells of north central Texas and at its outcrop.[19]

Below this lithographic limestone in Oklahoma are some 400 to 600 feet of "sugary" limestone, some sand (including the "Seminole sand"), and green shale beds which, together with the true "Wilcox" or St. Peter sandstone beneath, make up the Bromide formation, the latter also being classified as the top of the Simpson formation.[20] This description seems to fit the sequence below the lithographic limestone in north central Texas except that the sands and shales seem to be lacking. This section is variable in porosity in both regions. A siliceous formation which has evidently developed large irregular cavities now lined with secondary crystals as described by Paige[21] and as seen in the exposures of lower Ellenburger about five miles south of San Saba on the Burnet highway may represent the St. Peter sandstone in this region. However, this

[19]Udden, J. A., and Waite, V. V., Some Microscopic Characteristics of the Bend and Ellenburger Limestones. Univ. Texas Bull. 2703, 1927.

[20]Edson, Fannie C., *Ibid.*

[21]Paige, Sidney, U. S. Geol. Surv., Geol. Atlas, Llano-Burnet Folio 183 (1912), p. 7.

very porous formation has a striking resemblance to the Potosi drusy quartz development of the Ozarks which is much older than St. Peter sandstone and even older than the basal sand (the "Hominy") of the Simpson formation. More definite correlation of these beds with the Oklahoma section is much needed.

The underlying Wilberns and Cap Mountain formations and the basal Hickory sandstone are classified as upper Cambrian and consist of limestones, calcareous shales, and sandstones. Considerable glauconite furnishes a distinctive characteristic to these beds.

The underlying pre-Cambrian complex exhibits irregularity of composition and strength where exposed in the Central Mineral Region. It is interesting to note that some of these oldest and greatly metamorphosed sediments are graphitic.

These pre-Mississippian sediments as they appear in north central Texas seem to lack beds which might serve as a source for oil. However, it is very likely that they embrace shale deposits locally on the northeast and east toward the early Arbuckle and Ouachita basins. The Barnett, like the Chattanooga shale of Oklahoma, gives every appearance of having been petroliferous, and doubtless much oil and gas migrated from it into these various reservoir rocks, probably being driven from this shale as overburden and pressures increased and gradual compacting from a mud to a shale occurred. The eastward monoclinal slopes and excessive loading by thick Strawn beds doubtless caused westward migration of fluids from the Barnett and Bend shales during Strawn times. It seems important to restore these possible reservoir rocks (with their developing faults) to their early structural positions, this being the time when the main migration of oil probably occurred. With this in mind, the presence of oil and gas in these older beds seems entirely reasonable in areas now occupied by the Bend flexure or in the areas to the west of this, which, during Pennsylvanian times, were the highest structurally.

NEW FORMATION NAMES

The following formation names were found to be not listed with the Committee on Nomenclature, United States Geological Survey. These names appear to be well established in field usage and have been used on the outcrop map Plate I. The type locality and description of each is as follows:

1. NAME: Claytonville dolomite.
   AGE: Permian (Double Mountain).
   TYPE LOCALITY: Caps escarpment two miles west of Sweetwater in Nolan County, Texas, also at the town of Claytonville in southwestern Fisher County, Texas.
   DESCRIPTION: A white to grey dolomite one to three feet thick usually underlain by red sandstone followed by red shale and gypsum.
   (Name of Sweetwater, formerly used for this dolomite, was found to be preoccupied.)
2. NAME: McCaulley dolomite.
   AGE: Permian (Double Mountain).
   TYPE LOCALITY: At town of McCaulley in northeastern Fisher County, Texas, (part of town rests upon this bed).
   DESCRIPTION: A series of white chalky dolomites comprising a thickness of three to twenty feet, consisting of one inch to one foot dolomites separated by six inches to one foot partings of red and blue shales.
3. NAME: Guthrie dolomite.
   AGE: Permian (Double Mountain).
   TYPE LOCALITY: The town of Guthrie in central King County, Texas, underlies the town and outcrops along the South Wichita River or Salt River east of the town.
   DESCRIPTION: This formation consists of two beds of white dolomite, the upper member of which is one to six feet thick and is locally fossiliferous. The lower member is usually separated from the upper by a sandy gypsum one to five feet thick. It grades locally into gypsum. This member is usually one foot thick; however, in some areas it attains a thickness of five feet.
4. NAME: Royston formation.
   AGE: Permian (Double Mountain).
   TYPE LOCALITY: At Royston in northeastern Fisher County, Texas.
   DESCRIPTION: A series of about 100 feet consisting of red shales, gypsum, thin dolomites, and white calcareous shales.

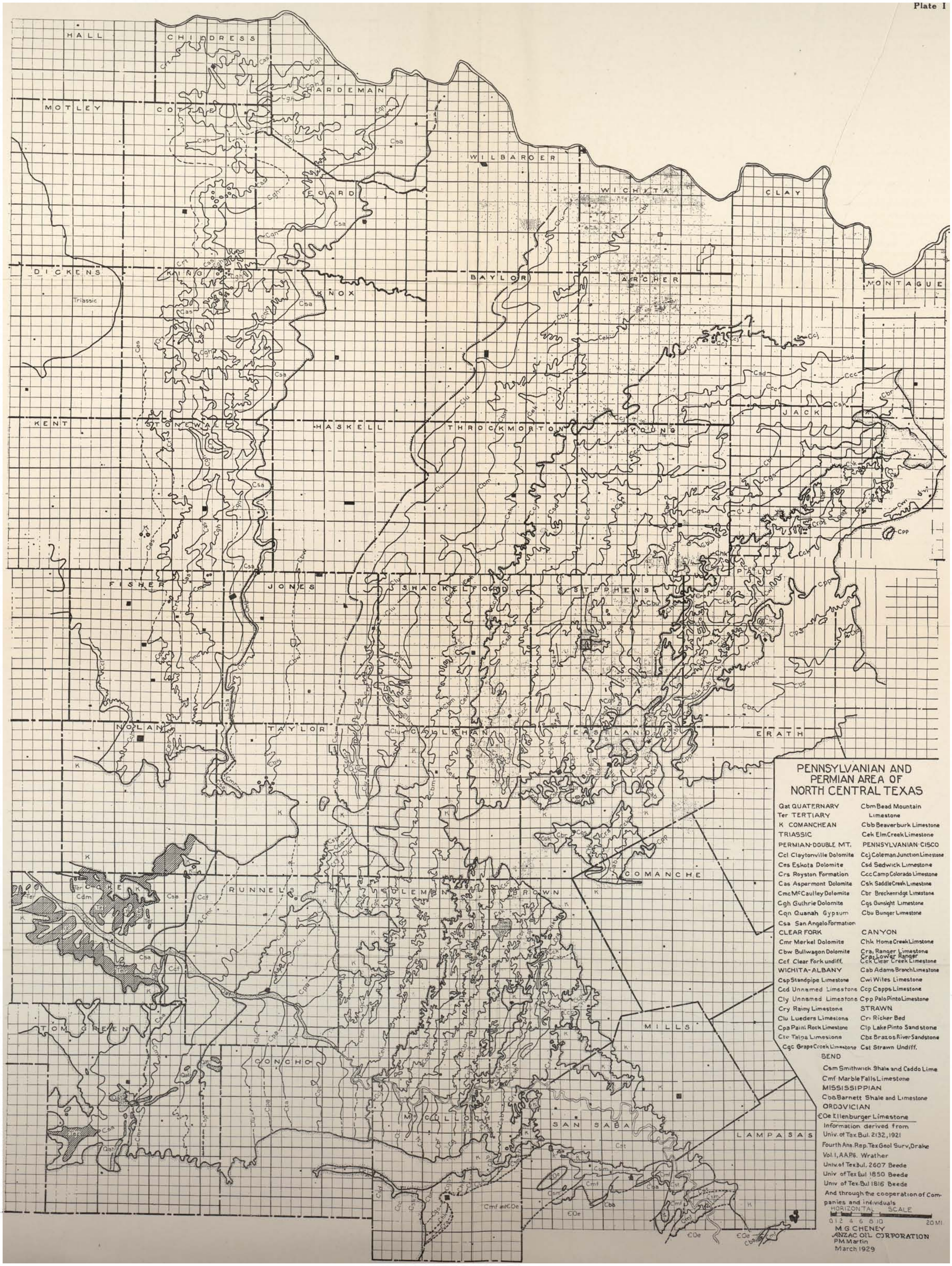
5. NAME: Standpipe limestone.
   AGE: Permian (Top member of Wichita Albany).
   TYPE LOCALITY: Lime outcropping at the base of the hill upon which the standpipe is located in eastern part of Abilene, in northeastern Taylor County, Texas.
   DESCRIPTION: Dark gray fossiliferous limestone one to three feet thick.
6. NAME: Rainy limestone.
   AGE: Permian (Upper Wichita Albany).
   TYPE LOCALITY: Along Rainy Creek 6 miles east of Abilene, Taylor County, Texas, forms escarpment south of T.&P. R.R.
   DESCRIPTION: One to three feet of dark gray to brown fossiliferous limestone locally white, overlain by brown and blue shales and underlain by red and blue shales.

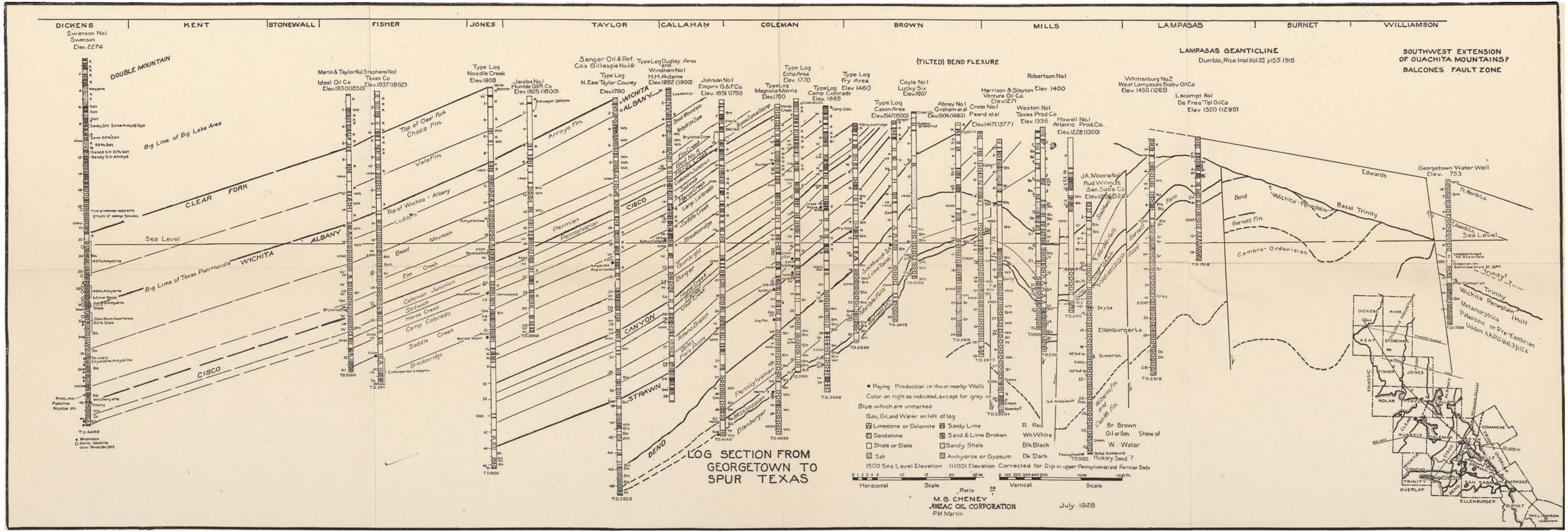
These formation or member names have been used in unpublished reports as follows:

Claytonville dolomite by T. M. Prettyman.
Guthrie dolomite by J. S. Hudnall and G. W. Pirtle.
Royston formation by J. S. Hudnall and G. W. Pirtle.
Standpipe limestone by W. A. Riney.
Rainy limestone by W. A. Riney.

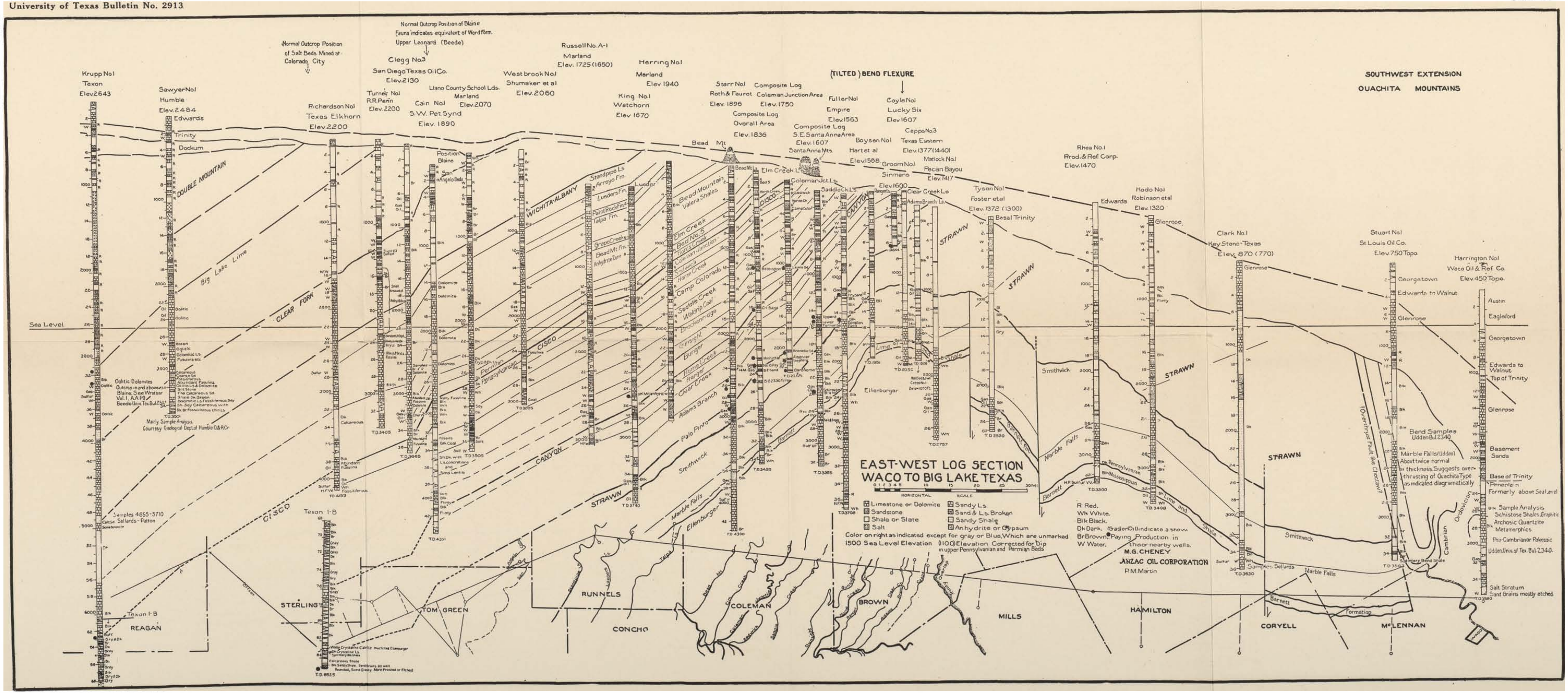
INDEX

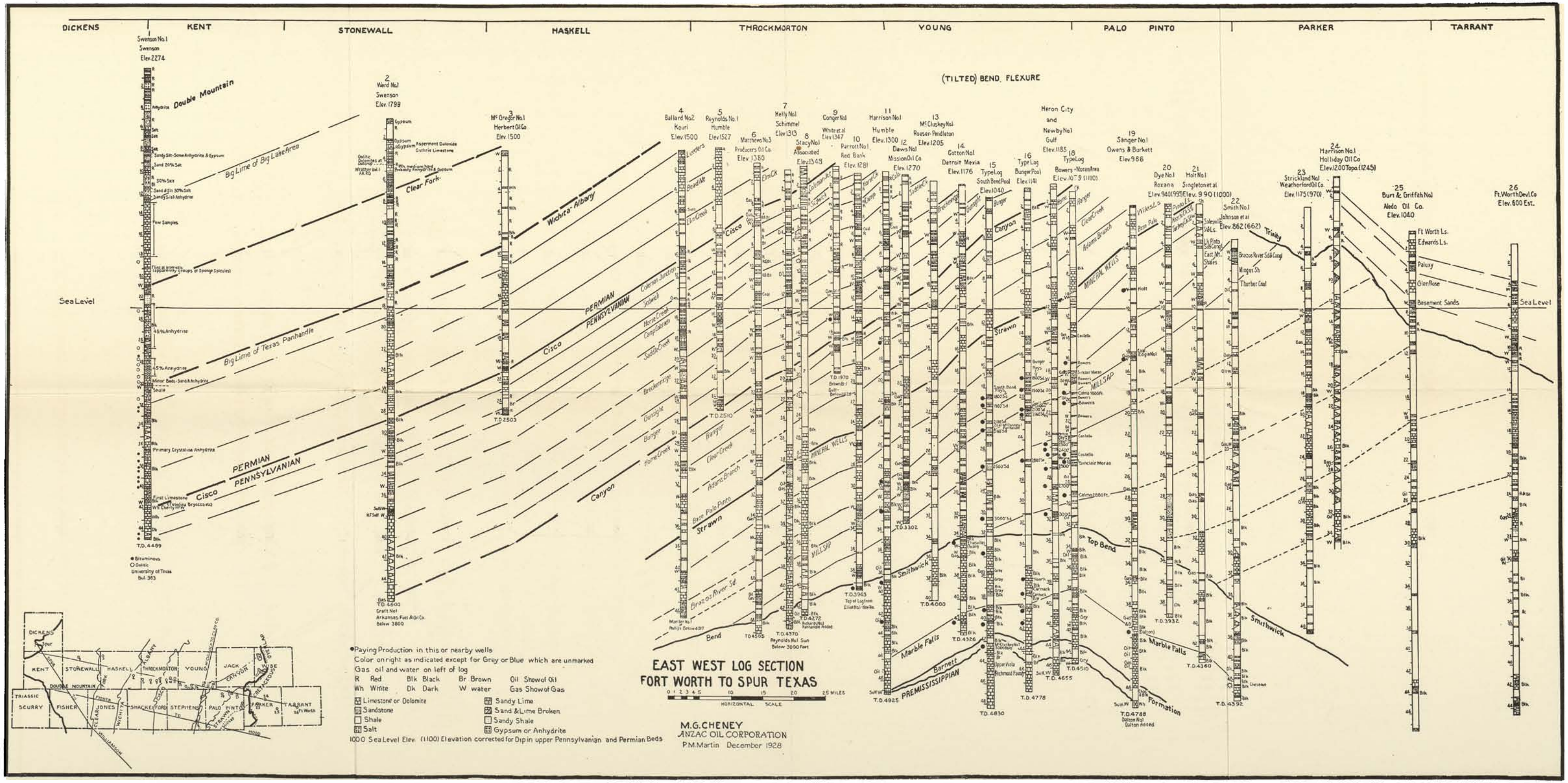
Plate I

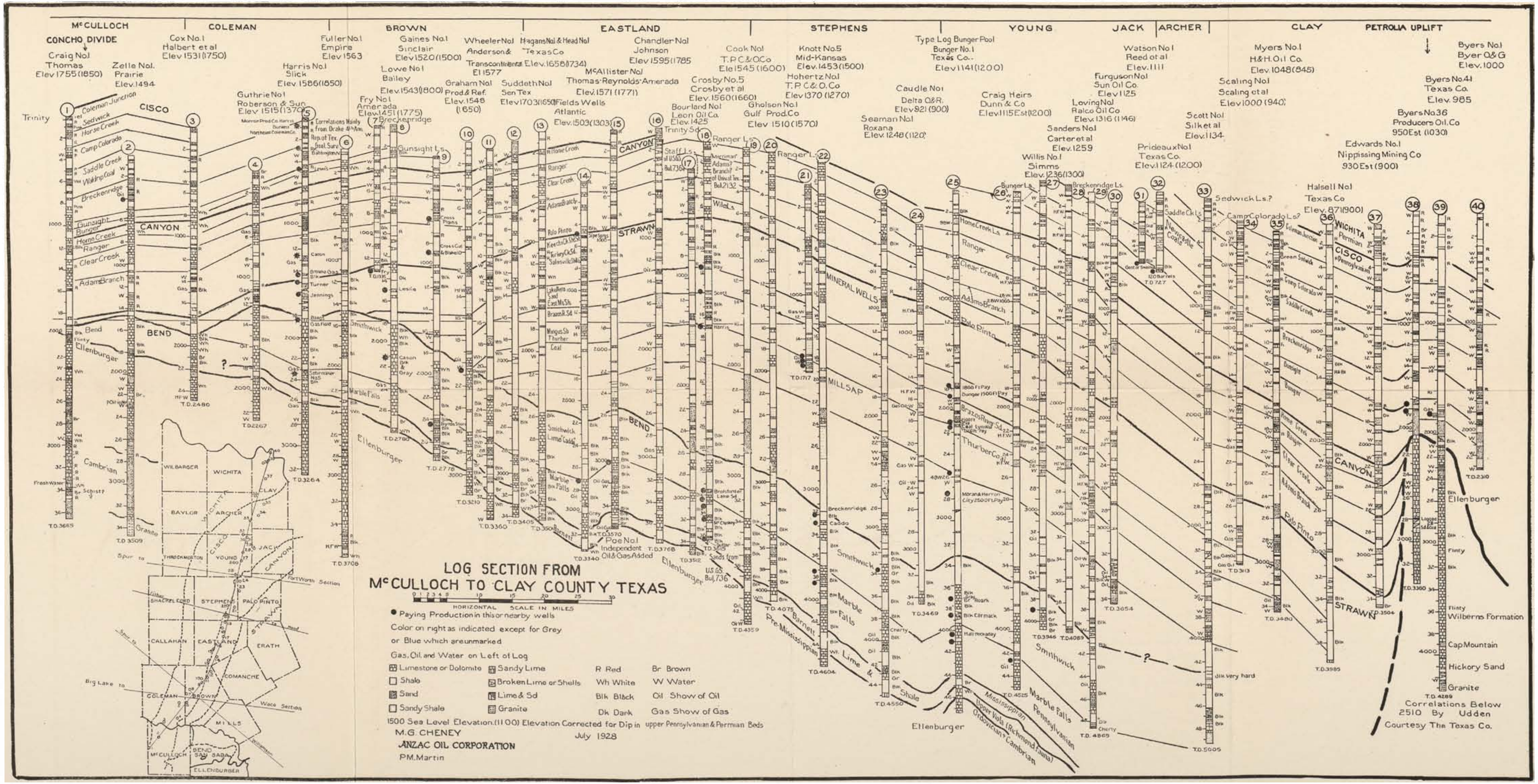

HALL
CHILDRESS
HARDEMAN
MOTLEY
COTTLE
WILBARGER
FOARD
WICHITA
CLAY
DICKENS
KING
KNOX
BAYLOR
ARCHER
MONTAGUE
Triassic
KENT
STONEWALL
HASKELL
THROCKMORTON
YOUNG
JACK
FISHER
JONES
SHACKELFORD
STEPHENS
NOLAN
TAYLOR
CALLAHAN
EASTLAND
ERATH
COKE
RUNNELS
COLEMAN
BROWN
COMANCHE
TOM GREEN
CONCHO
MILLS
McCULLOCH
SAN SABA
LAMPASAS
PENNSYLVANIAN AND
PERMIAN AREA OF
NORTH CENTRAL TEXAS
Qat QUATERNARY
Ter TERTIARY
K COMANCHEAN
TRIASSIC
PERMIAN-DOUBLE MT.
Ccl Claytonville Dolomite
Ces Eskota Dolomite
Crs Royston Formation
Cas Aspermont Dolomite
Cmc McCaulley Dolomite
Cgh Guthrie Dolomite
Cqn Quanah Gypsum
Csa San Angelo Formation
CLEAR FORK
Cmr Merkel Dolomite
Cbw Bullwagon Dolomite
Ccf Clear Fork undiff.
WICHITA-ALBANY
Csp Standpipe Limestone
Ccd Unnamed Limestone
Cly Unnamed Limestone
Cry Rainy Limestone
Clu Lueders Limestone
Cpa Paint Rock Limestone
Cte Talpa Limestone
Cgc Grape Creek Limestone
Cbm Bead Mountain Limestone
Cbb Beaverburk Limestone
Cek Elm Creek Limestone
PENNSYLVANIAN-CISCO
Ccj Coleman Junction Limestone
Csd Sedwick Limestone
Ccc Camp Colorado Limestone
Csk Saddle Creek Limestone
Cbr Breckenridge Limestone
Cgs Gunsight Limestone
Cbu Bunger Limestone
CANYON
Chk Home Creek Limstone
Cra₁ Ranger Limestone
Cra₂ Lower Ranger
Cck Clear Creek Limestone
Cab Adams Branch Limestone
Cwi Wiles Limestone
Ccp Capps Limestone
Cpp Palo Pinto Limestone
STRAWN
Cri Ricker Bed
Clp Lake Pinto Sandstone
Cbz Brazos River Sandstone
Cst Strawn Undiff.
BEND
Csm Smithwick Shale and Caddo Lime
Cmf Marble Falls Limestone
MISSISSIPPIAN
Cba Barnett Shale and Limestone
ORDOVICIAN
€Oe Ellenburger Limestone
Information derived from
Univ. of Tex. Bul. 2132, 1921
Fourth Ann. Rep. Tex Geol Surv, Drake
Vol. I, A.A.P.G. Wrather
Univ. of Tex. Bul. 2607 Beede
Univ of Tex Bul 1850 Beede
Univ of Tex. Bul 1816 Beede
And through the cooperation of Companies and individuals
HORIZONTAL SCALE
0 1 2 4 6 8 10 20 MI
M. G. CHENEY
ANZAC OIL CORPORATION
P. M. Martin
March 1929

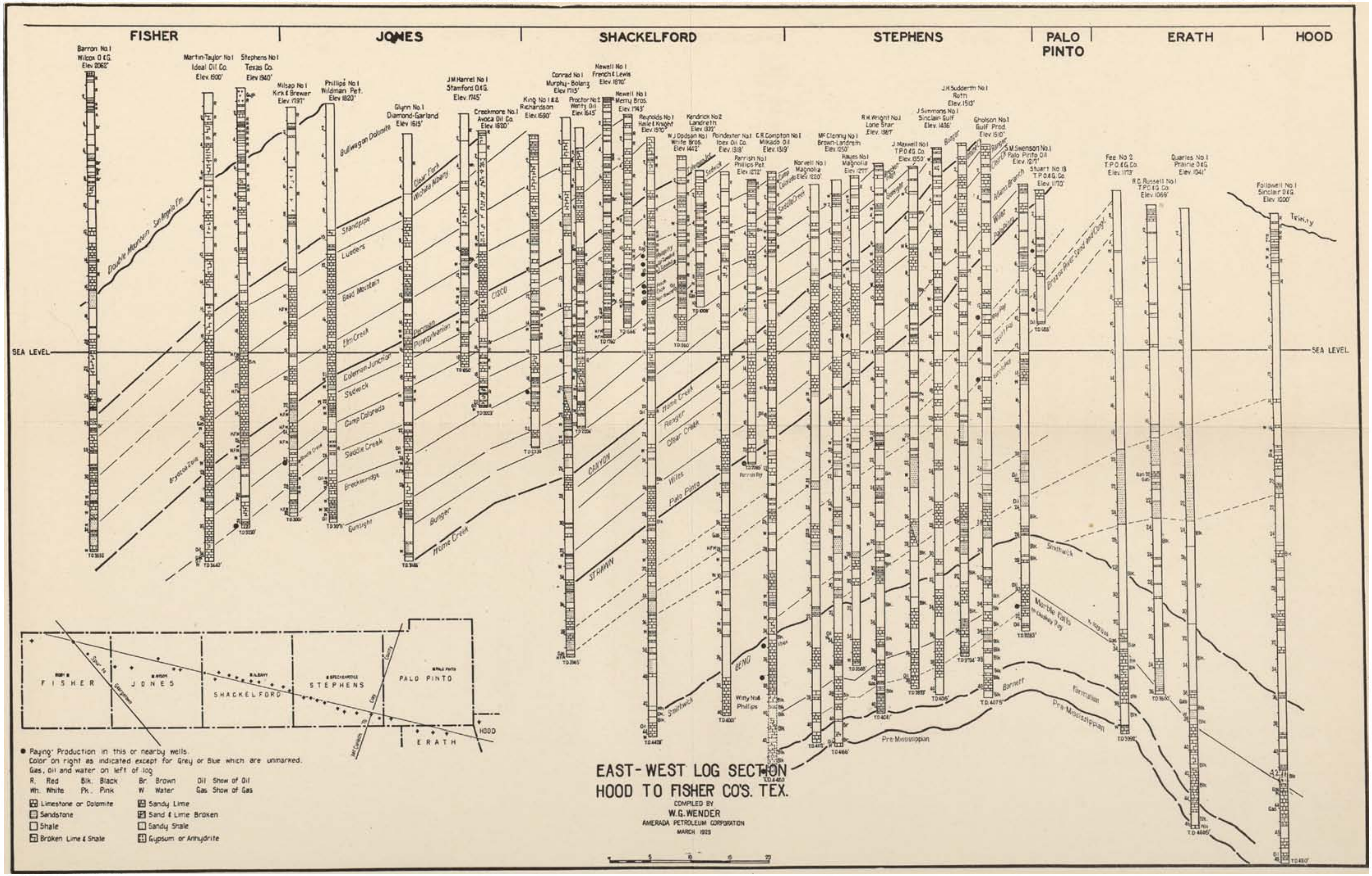


DICKENS
KENT
STONEWALL
FISHER
JONES
TAYLOR
CALLAHAN
COLEMAN
BROWN
MILLS
LAMPASAS
BURNET
WILLIAMSON
Swenson No.1 Swenson Elev. 2274
DOUBLE MOUNTAIN
Big Lime of Big Lake Area
CLEAR FORK
Sea Level
Big Lime of Texas Pan-Handle WICHITA
CISCO
Martin & Taylor No.1 Ideal Oil Co Elev. 1830 (1830)
Stephens No.1 Texas Co Elev. 1937 (1862)
Top of Clear Fork Choza Fm.
Vale Fm.
Top of Wichita - Albany
Lueders
ALBANY
Bead Mountain
Elm Creek
Coleman Junction
Sedwick
Horse Creek
Camp Colorado
Saddle Creek
Breckenridge
Type Log Noodle Creek Elev. 1808
Jacobs No.1 Humble O.&R. Co Elev. 1825 (1800)
Arroyo Fm.
Permian
Pennsylvanian
Sanger Oil & Ref. Co's Gillespie No.1 & Type Log N. East Taylor County Elev. 1780
WICHITA ALBANY
CISCO
CANYON
STRAWN
BEND
Type Log Dudley Area and Windham No.1 H.H. Adams Elev. 1982 (1900)
Johnson No.1 Empire G.&F. Co. Elev. 1851 (1751)
Type Log Magnolia-Morris Elev. 1700
Type Log Echo Area Elev. 1770
Type Log Camp Colorado Elev. 1665
Type Log Fry Area Elev. 1460
Pennsylvanian
Mississippian
Ellenburger
(TILTED) BEND FLEXURE
Type Log Cason Area Elev. 1547 (1500)
Coyle No.1 Lucky Six Elev. 1607
Abney No.1 Graham et al Elev. 1504 (1480)
Harrison & Slayton Venture Oil Co. Elev. 1271
Cross No.1 Peard et al Elev. 1417 (1377)
Robertson No.1 Elev. 1400
Weston No.1 Texas Prod. Co Elev. 1336
Howell No.1 Atlantic Prod. Co. Elev. 1228 (1300)
J.A. Moore No.1 Rud Wilmutt San Saba Co Elev. 1266 (1252)
Marble Falls
Ellenburger Ls
LAMPASAS GEANTICLINE
Dumble, Rice Inst. Vol. III p155 1916
Whittenburg No.2 West Lampasas Bisby Oil Co Elev. 1450 (1265)
Lecompt No.1 De Free Tal Oil Co Elev. 1520 (1290)
Bend
Barnett Fm.
Wichita Peneplain
Basal Trinity
Edwards
Cambro-Ordovician
SOUTHWEST EXTENSION OF OUACHITA MOUNTAINS?
BALCONES FAULT ZONE
Georgetown Water Well Elev. 753
Sea Level
Trinity
Wichita Peneplain
Metamorphics
Paleozoic or Pre-Cambrian
Udden A.A.P.G. Vol. 3 p124
• Paying Production in this or nearby Wells
Color on right as indicated, except for grey or Blue which are unmarked
Gas, Oil, and Water on left of log
Limestone or Dolomite
Sandy Lime
Sandstone
Sand & Lime Broken
Shale or Slate
Sandy Shale
Salt
Anhydrite or Gypsum
R Red
Wh White
Blk Black
Dk Dark
Br Brown
Oil or Gas
Show of
W. Water
1500 Sea Level Elevation (1100) Elevation Corrected for Dip in upper Pennsylvanian and Permian Beds
Horizontal Scale
Vertical Scale
LOG SECTION FROM GEORGETOWN TO SPUR TEXAS
M. G. CHENEY
ANZAC OIL CORPORATION
P.M. Martin
July 1928

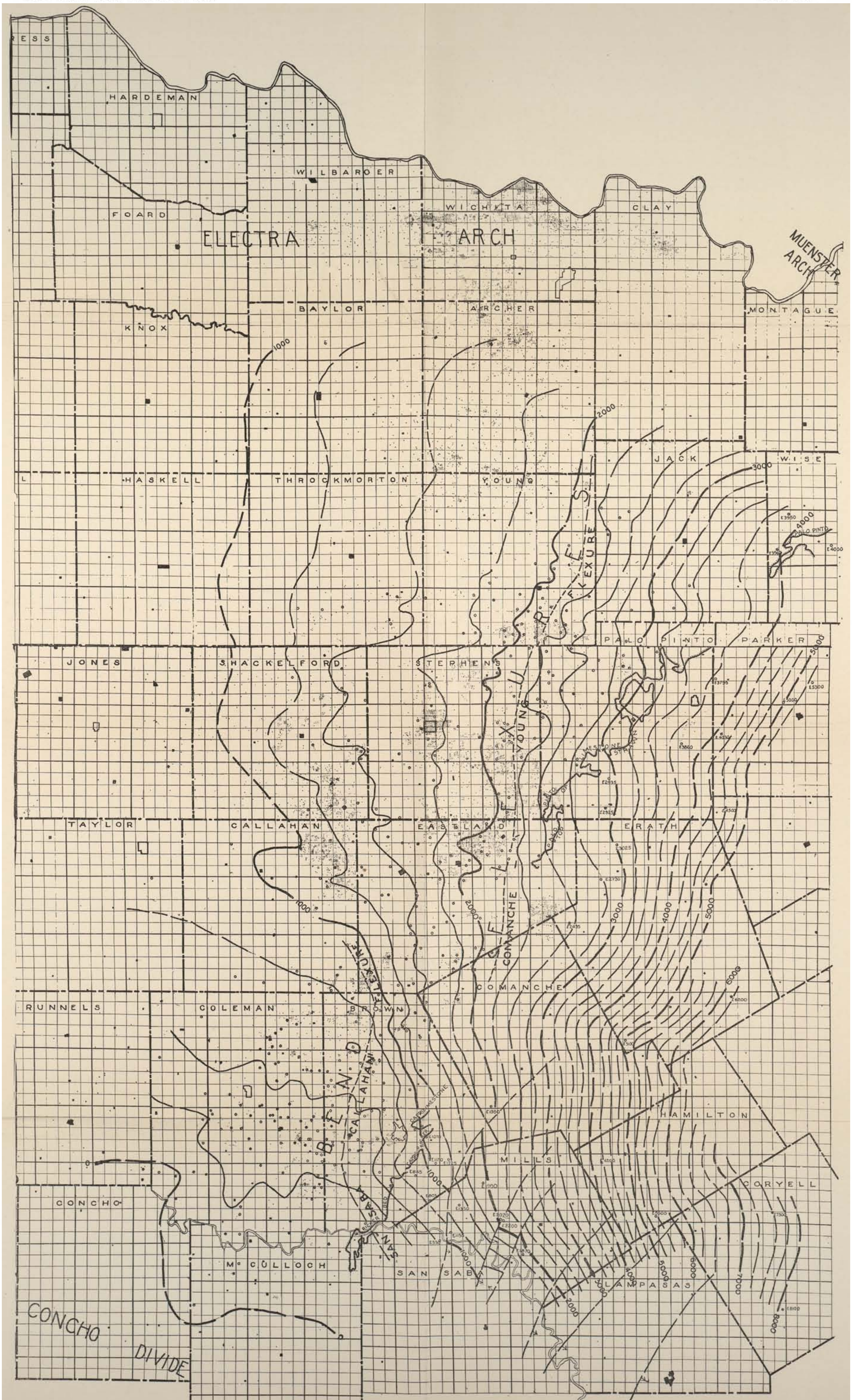

EAST-WEST LOG SECTION
WACO TO BIG LAKE TEXAS
SOUTHWEST EXTENSION
OUACHITA MOUNTAINS
(TILTED) BEND FLEXURE
Krupp No1
Texon
Elev.2643
Sawyer No1
Humble
Elev.2484
Richardson No1
Texas Elkhorn
Elev.2200
Clegg No3
San Diego Texas Oil Co.
Elev.2130
Turner No1
R.R.Penn
Elev.2200
Cain No1
S.W. Pet Synd
Elev. 1890
Llano County School Lds.
Marland
Elev.2070
Westbrook No1
Shumaker et al
Elev.2060
Russell No. A-1
Marland
Elev. 1725 (1650)
King No.1
Watchorn
Elev 1670
Herring No1
Marland
Elev 1940
Starr No1
Roth & Faurot
Elev. 1896
Composite Log
Coleman Junction Area
Elev. 1750
Composite Log
Overall Area
Elev. 1836
Composite Log
S.E. Santa Anna Area
Elev. 1607
Fuller No1
Empire
Elev. 1563
Boysen No1
Hart et al
Elev. 1588
Coyle No1
Lucky Six
Elev 1607
Capps No3
Texas Eastern
Elev. 1377 (1440)
Matlock No1
Pecan Bayou
Elev. 1417
Groom No1
Sirmans
Elev. 1600
Tyson No1
Foster et al
Elev. 1372 (1300)
Rhea No.1
Prod. & Ref. Corp.
Elev. 1470
Hodo No1
Robinson et al
Elev. 1320
Clark No.1
Key Stone-Texas
Elev. 870 (770)
Stuart No1
St. Louis Oil Co.
Elev. 750 Topo.
Harrington No1
Waco Oil & Ref. Co.
Elev. 450 Topo.
Texon 1-B
Sea Level
Trinity
Dockum
DOUBLE MOUNTAIN
Big Lake Lime
CLEAR FORK
WICHITA-ALBANY
CISCO
CANYON
STRAWN
Smithwick
Marble Falls
Ellenburger
Barnett
Palo Pinto
Adams Branch
Bead Mt
Edwards
Glenrose
Georgetown
Austin
Eagleford
Basement Sands
Base of Trinity
Cambrian
Ordovician
Overthrust Fault like Choctaw?
Limestone or Dolomite
Sandstone
Shale or Slate
Salt
Sandy Ls.
Sand & Ls. Broken
Sandy Shale
Anhydrite or Gypsum
R Red.
Wh White.
Blk Black.
Dk Dark.
Br Brown.
W Water.
Color on right as indicated except for gray or Blue, Which are unmarked
1500 Sea Level Elevation (1100) Elevation Corrected for Dip in upper Pennsylvanian and Permian Beds
M.G. CHENEY
ANZAC OIL CORPORATION
P.M. Martin
REAGAN
STERLING
TOM GREEN
RUNNELS
CONCHO
COLEMAN
BROWN
MILLS
HAMILTON
CORYELL
McLENNAN


DICKENS
KENT
STONEWALL
HASKELL
THROCKMORTON
YOUNG
PALO PINTO
PARKER
TARRANT
(TILTED) BEND FLEXURE
Sea Level
Double Mountain
Big Lime of Big Lake Area
Clear Fork
Wichita-Albany
Big Lime of Texas Panhandle
PERMIAN
PENNSYLVANIAN
Cisco
Canyon
Strawn
Millsap
Mineral Wells
Smithwick
Marble Falls
Barnett
PREMISSISSIPPIAN
Top Bend
Bend
Trinity
Brazos River Sd.
•Paying Production in this or nearby wells
Color on right as indicated except for Grey or Blue which are unmarked
Gas oil and water on left of log
R Red
Wh White
Blk Black
Dk Dark
Br Brown
W water
Oil Show of Oil
Gas Show of Gas
Limestone or Dolomite
Sandstone
Shale
Salt
Sandy Lime
Sand & Lime Broken
Sandy Shale
Gypsum or Anhydrite
1000 Sea Level Elev. (1100) Elevation corrected for Dip in upper Pennsylvanian and Permian Beds
EAST WEST LOG SECTION
FORT WORTH TO SPUR TEXAS
HORIZONTAL SCALE
25 MILES
M.G. CHENEY
ANZAC OIL CORPORATION
P.M. Martin December 1928


McCULLOCH
COLEMAN
BROWN
EASTLAND
STEPHENS
YOUNG
JACK
ARCHER
CLAY
PETROLIA UPLIFT
CONCHO DIVIDE
LOG SECTION FROM
McCULLOCH TO CLAY COUNTY TEXAS
HORIZONTAL SCALE IN MILES
● Paying Production in this or nearby wells
Color on right as indicated except for Grey
or Blue which are unmarked
Gas, Oil, and Water on Left of Log
Limestone or Dolomite
Shale
Sand
Sandy Shale
Sandy Lime
Broken Lime or Shells
Lime & Sd
Granite
R Red
Wh White
Blk Black
Dk Dark
Br Brown
W Water
Oil Show of Oil
Gas Show of Gas
1500 Sea Level Elevation. (1100) Elevation Corrected for Dip in upper Pennsylvanian & Permian Beds
M.G. CHENEY
ANZAC OIL CORPORATION
P.M. Martin
July 1928
CISCO
CANYON
STRAWN
BEND
Ellenburger
Cambrian
MINERAL WELLS
MILLSAP
Marble Falls
Smithwick
WICHITA
Correlations Below
2510 By Udden
Courtesy The Texas Co.


FISHER
JONES
SHACKELFORD
STEPHENS
PALO PINTO
ERATH
HOOD
SEA LEVEL
Double Mountain San Angelo Fm.
Bullwagon Dolomite
Clear Fork
Wichita Albany
Standpipe
Lueders
Bead Mountain
Elm Creek
Permian
Pennsylvanian
Coleman Junction
Sedwick
Camp Colorado
Saddle Creek
Breckenridge
Gunsight
Bunger
Home Creek
CISCO
CANYON
STRAWN
Ranger
Clear Creek
Wiles
Palo Pinto
BEND
Smithwick
Marble Falls
Barnett
Pre-Mississippian
Trinity
Brazos River Sand and Cong.
Paying Production in this or nearby wells.
Color on right as indicated except for Grey or Blue which are unmarked.
Gas, oil and water on left of log
R. Red Blk. Black Br. Brown Oil Show of Oil
Wh. White Pk. Pink W Water Gas Show of Gas
Limestone or Dolomite
Sandstone
Shale
Broken Lime & Shale
Sandy Lime
Sand & Lime Broken
Sandy Shale
Gypsum or Anhydrite
FISHER
JONES
SHACKELFORD
STEPHENS
PALO PINTO
ERATH
HOOD
EAST-WEST LOG SECTION
HOOD TO FISHER CO'S. TEX.
COMPILED BY
W. G. WENDER
AMERADA PETROLEUM CORPORATION
MARCH 1929


PRE-MISSISSIPPIAN SURFACE
NORTH CENTRAL TEXAS
AND SOUTHERN OKLAHOMA
0 2 4 6 8 10 12 14 16 18 20 22 24 26 MILES
February 1929
ANZAC OIL CORPORATION
M.G. CHENEY
P.M. Martin
B.T. Denotes Bend & Barnett Thickness
Areas of Comercial Production
Well in which important Production has been found in Pre-Mississippian formations
Well showing oil or gas in pre Mississippian formations
E Estimated, Depth or Elevation of well
-98 to -3000 Metamorphics, Schistoze Shale & Cherts
Stanley
Woodford
(-1060 Huronian(?) Quartzite, Udden)
Base of Trinity
BALCONES
BALCONES FAULT ZONE
OUACHITA OVERTHRUSTING
STEEP DIP ZONE OF
CLEVELAND
POTTAWATOMIE
SEMINOLE
CADDO
GREER
KIOWA
GRADY
McCLAIN
HARMON
COMANCHE
GARVIN
JACKSON
STEPHENS
MURRAY
TILLMAN
HARDEMAN
COTTON
CARTER
JEFFERSON
FOARD
WILBARGER
WICHITA
LOVE
CLAY
MONTAGUE
COOKE
KNOX
BAYLOR
ARCHER
JACK
WISE
DENTON
HASKELL
THROCKMORTON
YOUNG
PARKER
TARRANT
DALLAS
JONES
SHACKELFORD
STEPHENS
PALO PINTO
HOOD
JOHNSON
ELLIS
TAYLOR
CALLAHAN
EASTLAND
ERATH
SOMERVELL
HILL
COMANCHE
BOSQUE
RUNNELS
COLEMAN
BROWN
HAMILTON
McLENNAN
MILLS
CORYELL
CONCHO
FALLS
McCULLOCH
SAN SABA
LAMPASAS
BELL
MENARD
MASON
BURNET
KIMBLE
GILLESPIE
BLANCO



STRAWN THICKNESS MAP

SCALE: 1 INCH=16 MILES